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ABSTRACT

The major unifying concept for each of the disciplinary sections in this curriculum infusion unit is that the blue mussel is an easily obtainable, high quality, very palatable seafood. A section is provided for teacher familiarity with the anatomy and ecological background of the mussel. The guide is arranged by discipline areas. Sections provide objectives and directions for activities involving use of mussels to portray concepts of the discipline. (RE)

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BLUE MUSSEL

SE 029 135

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THE EDIBLE BLUE MUSSEL

A Learning Experience for Marine Education

Produced by

Northern New England Marine Education Project

Supported in Part by

A grant from the National Sea Grant,

Maine - New Hampshire

1978

Title: The Edible Blue Mussel

*MARINE CONCEPT:

1. An Abundance of Water Makes the Earth Unique in Our Solar System.
   1.2 Water in the environment contains a variety of substances in suspension and in solution.
      1.24 Many substances dissolved or suspended in water are recycled through biological, geological and chemical systems.

3. Aquatic Organisms Interact in Complex Ecosystems.
   3.2 Aquatic organisms are adapted to their environments in different ways.
      3.21 Aquatic organisms are adapted developmentally, structurally, functionally, and behaviorally to their environments.

4. Man is Part of Aquatic Ecosystems.
   4.1 Aquatic environments have affected the course of history and the development of human cultures.
      4.12 Proximity to aquatic environments and the availability of aquatic resources have influenced the cultures of many societies.
   4.2 Man's activities may deplete and degrade aquatic ecosystems.
      4.21 Exploitation of aquatic environments can cause depletion of many marine and freshwater species and the degradation of habitats.
   4.3 Existing technology is capable of maintaining the health and usefulness of aquatic ecosystems.
      4.32 Regional and international agreements will be essential for the conservation of aquatic resources.

Grade Level: 5-12 with variations

School Subjects: Science, Math, Social Studies, Language Arts, Home Economics, and Art

Periods: Various

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Editor: Harry H. Dresser, Jr.

*The conceptual scheme is from Marine Environment Proposed Conceptual Scheme, 1973, which is available from Dr. Robert Stegner, Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.

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INTRODUCTION

The major unifying topic for each of the disciplinary sections in this curriculum infusion unit is that the blue mussel, (Mytilus Edulis), is an easily obtainable, high quality, very palatable seafood. The teacher(s) working with this unit should immediately begin searching for stores where mussels can be obtained. If any teacher is experienced at gathering wild mussels and is positively sure of the safety and laws of a specific area, she/he should feel free to gather rather than purchase the mussels. It is up to the teacher(s) to decide how many mussels will be needed. The preparation and tasting of mussels is an essential part of this unit. Of course, if any person is vehemently opposed to tasting mussels, she/he should not be forced to do so. Hopefully you and many others will open the doors to a delicious new addition to your diets.

TEACHER BACKGROUND

The blue mussel (Mytilus Edulis) is one of the most common shellfish found along the coastal areas of northern New England. In European nations mussels are considered one of the finest tasting shellfish available. Here in America not many people realize that mussels are a tasty and nutritious food and subsequently, very few people have ever eaten them.

The blue mussel is a member of a group of animals called Mollusks. In general, most mollusks have a shell of some type, and live in the water or in wet places. Mussels are no exception. Blue mussels can be found growing attached to rocks, pilings, or almost anything solid which is covered with sea water at some time each day. Often mussels grow in large clumps attached to each other on mud flats. These clumps can be seen at low tide and this is when they are gathered to be sold.

Mussels are "filter feeders." In other words they obtain their food by pumping a steady stream of water through a filter which collects tiny microscopic plants and animals called plankton. The plankton is then transported on tiny waving hairs called cilia through the mouth to the stomach where it is digested. Digested food travels through an intestine and wastes are excreted with the current of filtered water leaving the mussel. The food filters also have another very important function. They are the gills which absorb oxygen and give off carbon dioxide. So, by pumping a steady stream of water through the "gill-filters" the mussel can obtain food and oxygen in one process.

Because mussels are filter feeders, those that are submerged for the longest amounts of time can obtain the most food during each day. As one proceeds from the highest levels where mussels can grow (just below the high tide level) to the lowest areas where they grow (where they are covered by water constantly) the quality and quantity of mussels increases. Why?

One problem which occurs with mussels and other filter feeders is paralytic shellfish poisoning which results from eating filter feeding organisms which have been exposed to the "Red Tide." A "Red tide" is caused by an extremely large population of a certain kind of dinoflagellate, Gonyaulax, which is a type of plankton. When filter feeders eat the red tide organisms they build up a toxin which is produced by the dinoflagellates. If we were to eat a mussel or clam which has stored this toxin, we could possibly become very sick. Because mussels filter more rapidly than most other filter feeders they are particularly susceptible to "red tides." This is why occasionally the taking of mussels is prohibited because of a red tide, while in the same location there is no ban on taking clams.

One beneficial aspect of the very efficient filtering of mussels is that mussels have a rapid growth rate. Thus it is quite feasible to grow mussels like a farmer raises vegetables or chickens. In fact, in European nations aquaculture is quite a profitable method of obtaining mussels for market. Aquaculture is the raising and harvesting of marine and aquatic organisms. The three major methods of mussel farming are raft culture, pole culture and bottom culture.

In Maine mussels are raised by a number of aquaculturists. They are usually grown on ropes suspended from rafts. This is the raft culture method which is very common in the Galician Bays of Spain.

The pole culture is common along the coast of France. Oak poles are driven into the mud below the low tide mark. Mussels grow on the poles in the zone between the high and low tide marks. These mussels are thinned, with those removed being transplanted to other poles. A single pole will produce about 25 pounds of live mussels per year. Presently, there are over 2.5 million poles along the French coast.

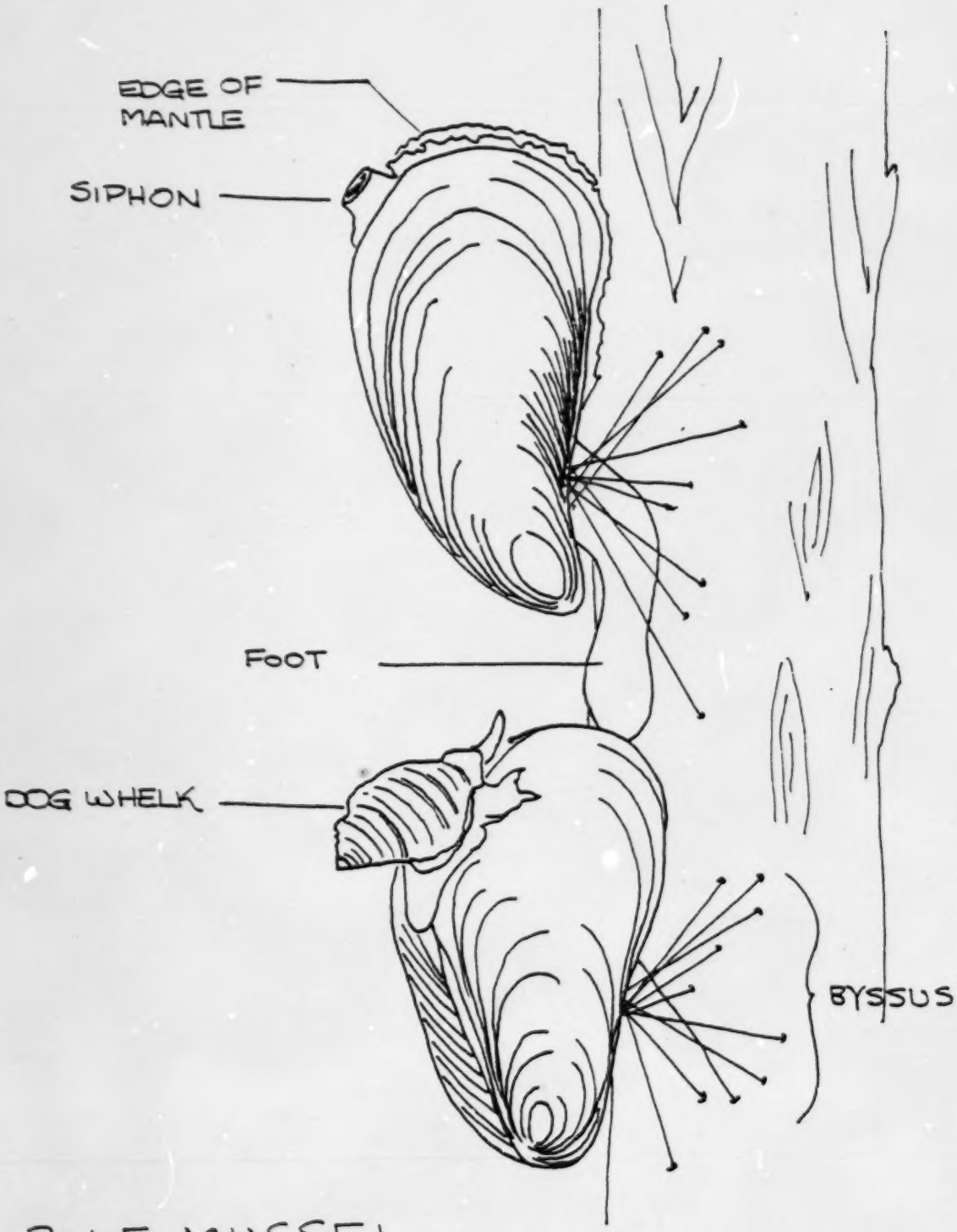
The bottom culture method involves mechanized harvesting of mussels which grow on the bottom as they would naturally. This method is most common in the North Sea countries.

Culturing mussels not only improves the yield of mussels, but it also improves the quality of the mussels produced. Mussels, like oysters, produce pearls. These pearls have no commercial value, and they can be a major annoyance to anyone eating the mussels. The pearls are formed as the mussel surrounds parasites in mother-of-pearl. It takes over eighteen months of growth for the mussel to produce pearls which are large enough to be noticed; so, if mussels can be raised to market size in less than eighteen months, they present no potential hazard to teeth through the presence of pearls. Cultured mussels can be raised to market size in less than eighteen months, while wild mussels take several years to reach the same size. This makes the value of the cultured mussel much higher than wild mussels.

Life Cycle

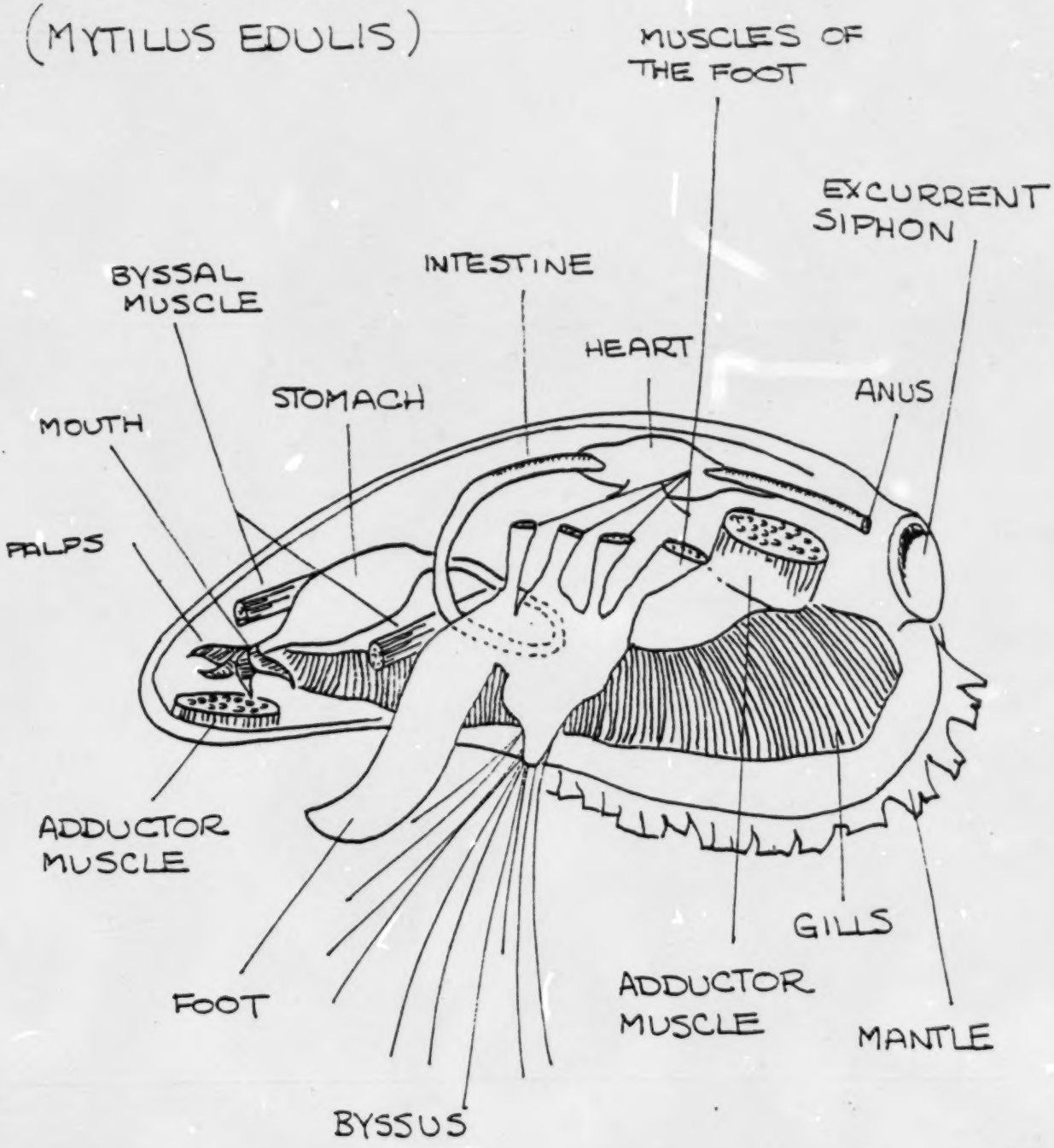
The gravid female mussel, which may be one year old, or older, releases from 5 to 25 million eggs into the water at spawning time. This time is determined in large measure by the phases of the moon. At the same time, the male releases a steady stream of milt into the water. The fertilized eggs develop rapidly, becoming free-swimming larvae in a few days. These larvae take the adult form within several weeks, and remain afloat for a month or more either hanging from the surface by byssus threads, or floating with an air bubble trapped between their shells.

The young adult mussel will eventually set on some substrate and attach itself with byssus threads. The foot which guides attachment of the threads has a sucker at its tip which permits the mussel to remain capable of movement throughout its adult life. Despite this capability, mussels usually remain attached to their substrate once they've set.



BLUE MUSSEL
(MYTILUS EDULIS)

BLUE MUSSEL
(MYTILUS EDULIS)



Suggested Activities

A. Practice writing letters to organizations to obtain information or resources.

B. Practice writing thank you letters to appropriate resource people and to those agancies and individuals that have responded with information and material.

C. Write an original article on a topic concerning mussels.

D. Put out a newsletter on what the class did for this unit.

Further Information on Suggested Activities

A. There are available from certain organizations, many brochures, pamphlets, and papers concerned with mussels and related topics. Your state department of marine resources, the University of New Hampshire Sea Grant, the University of Maine Sea Grant, the Ira C. Darling Center, Walpole, Maine 04573, and the National Oceanographic and Atmospheric Association (NOAA), have some information.

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University of New Hampshire Sea Grant
UNH Marine Program
Marine Program Building
Durham, N.H. 03824

University of Maine Sea Grant
University of Maine at Orono
Coburn Hall
Orono, Maine 04469

Ira C. Darling Center
Walpole, Maine 04573

National Oceanic and Atmospheric Administration
U. S. Department of Commerce
Washington, D. C. 20402

These are just a few sources of information; it is up to you and your classes to come up with as many as possible. You should have your classes write to these organizations to obtain any information available. Some topics which might be considered relative to mussels are laws, red tides, aquaculture, uncommon edible seafoods, shellfish harvesting and the economics of shellfish harvesting. (Check with the social studies and science teachers using this unit for related topics, as they may also want to send for information. Perhaps this could be an interdisciplinary exercise.)

B. During the time this unit is being taught in your school there should be opportunities to write thank you notes to appropriate people, for instance, resource people who have helped in class, store owners who have donated material, organizations that have sent resource information, and parents who have donated material. All of these people deserve thanks.

C. Have your students write an original story or research paper on some mussel related topic. A few examples are listed below.

   a. A step by step description of how a meal using mussels is prepared.

   b. How mussels are farmed.

   c. How mussels are harvested for sale.

   d. The history of the mussel's use by people.

   e. If I were in the mussel business I would . . .

D. In each class that the students do mussel related work, they should record what they have done. When they have finished with the unit, students should work as one group to make a newsletter for distribution throughout the school, to parents, and to any interested people about their new experiences with the mussel. Writing, editing and publication tasks can be divided.

SOCIAL STUDIES

The objectives of the Social Studies section of the mussel unit are:

A. An understanding of the various types of mussel culturing throughout the world.

B. To research, find, and discuss various foods which are commonly eaten throughout the world but are seldom eaten in America. (And try some!)

C. To discuss the importance of mussels and other shellfish in American history. (from The Mussel Cookbook)

D. Discuss the laws and safety aspects associated with the gathering of wild mussels (and the reasons for the laws). (see related objectives in science and language arts sections)

Social Studies Activities

A. 1. Around the world many countries use mussels as a major food product. Because the numbers of wild mussels are limited, many countries have developed methods of raising mussels as a farmer would raise vegetables. In fact, mussel farmers need only place in the water a suitable solid object (substrate) onto which larval mussels can attach. They are then in business! Mussel farming isn't all that easy, though. Once you start there is a lot of work.

To begin the social studies section of this unit have your students research (using The Mussel Cookbook and any other resources available) the various methods of raising and obtaining mussels throughout the world. These major methods are raft culture, pole culture, bottom culture and harvesting wild mussels. (See the teacher background material for explanations of these methods.)

2. Once suitable information has been obtained, attempt to determine the most efficient method of obtaining mussels for food, locally and worldwide. Take into consideration many aspects such as quantities of meat, quality of the meat, time required to reach marketable size, ease of harvest, and applicability to your area. For example, raft culture may provide the best results in Spain, but if you know of an area with many pilings of old piers stuck in the mud wouldn't pole culture provide an easier, somewhat more efficient alternative? A class debate might be the most effective method of determining the "best way." An excellent additional

resource available from Maine Sea Grant Publications, Ira C. Darling Center, Walpole, Maine, 04573, is titled Raft Cultivation of Mussels in Maine Waters--Its Practicability, Feasibility and Possible Advantages.

B. There are many foods eaten throughout the world which are seldom eaten in America, like mussels. It seems that most Americans prefer a hamburger and french fries to french fried squid and seaweed soup. But, how many Americans have ever tried squid or seaweed?

Have your class investigate and discuss the various types of food consumed in foreign countries that are seldom eaten in America. Next decide which ones might be available to you and try them as a class. Many specialty foods can be purchased at grocery stores or you may be able to get leads as to where they can be found. Model Market on Free Street in Portland carries a large variety of unusual foods.

C. Have your class discuss the importance easily obtainable shellfish may have had in America's history. Some research may be needed to promote discussion. As a start try The Mussel Cookbook (Harvard University Press, 1977).

D. Obtain a recent shellfishing lawbook from the State Department of Marine Resources and discuss the various laws concerning the gathering of shellfish comercially and for personal use. What might be the reasons for such laws? Address lawbook requests to:

Division of Marine Patrol
Department of Marine Resources
State House
Augusta, Maine 04333

SCIENCE

The objectives in the science section of the mussel unit are:

A. To familiarize the students with the habitat of the blue mussel (Mytilus Edulis), and to show their relationships to other organisms.

B. To familiarize the students with the external features and the basic internal anatomy of the blue mussel.

C. To gain an understanding of the nutritional value of the blue mussel as compared with other common foods.

D. To research and discuss the "Red Tide," its dangers, and its economic impact.

E. To investigate and discuss the aquaculturing of different species.

Science Activities

A. 1. Have your students research and report on mussels habitats. Have them look for information on the relationships mussels have with other organisms, such as whelks and plankton.

2. Take a field trip to the coast and observe areas where mussels are found and their relationships to other organisms. Take several mussels and 10-20 gallons of seawater back to your classroom with you.

B. 1. Using the diagrams included, first observe the external anatomy of the blue mussel, then dissect one carefully and observe the internal anatomy.

2. Place a live mussel in a container of sea water and observe its movements. When the mussel begins to filter, add some carmine powder (obtainable from your chemistry department) and observe the filter currents. Then determine where the water enters and where it exits. After about 20 minutes dissect the mussel carefully and observe where the carmine powder has collected.

C. Look at the comparison between mussel meat and T-bone in the chart which follows.

3.5 ounces (100 grams) raw meat	Common blue mussel	T-bone steak (choice)
Calories	95	395
Protein	14.4 grams	14.7 grams
Fat	2.2 grams	37.1 grams
Carbohydrates	3.3 grams	0.0 grams
Calcium	88 milligrams	8 milligrams
Phosphorus	236 milligrams	135 milligrams
Iron	3.4 milligrams	2.2 milligrams
Thiamin	0.16 milligrams	0.06 milligrams
Riboflavin	0.21 milligrams	0.13 milligrams

SOURCE: United States Department of Agriculture Handbook No. 8, Composition of Foods, December 1963.

Research and make comparisons between mussel meat and other common foods. (You might begin by writing to the U.S.D.A. for Handbook No. 8, Composition of Foods, December 1963.)

D. 1. Have your students research the "red tide" in the library. Some topics to be discussed are:

a. What is the "red tide"?
b. Why is it called a "red tide"?
c. What are the dangers of a "red tide"?
d. What economic impact has the "red tide" had?
e. What organisms are affected by the "red tide"?
f. What might cause a "red tide"?

2. If a resource person is scheduled to talk to your classes on a topic concerning mussels, prepare some questions on how the "red tide" has affected him/her.

E. Have your class research and discuss the topic of aquaculture as it relates to mussels and other marine organisms throughout the world. Discuss some scientific aspects of aquaculture such as production rates and product quality. (Students may be conducting a similar study in their social studies classes, so it might be beneficial to meet with social studies teachers to discuss when and when not to overlap.)

The objectives of the math section of the mussel unit are:

A. To practice converting various American units by multiplying recipes. For example, tripling a recipe calling for 2 cups of mussel meat would call for $1\frac{1}{2}$ quarts of mussel meat.

B. To practice converting multiple metric units as in A above.

C. To practice solving various quantity problems.

D. To practice solving word problems involving mussel economics.

E. To determine the actual cost of the ingredients used in a recipe.

Math Activities

Because you as the math teacher know what concepts in your subject area will be best applied during the use of this unit on mussels, you can best develop the word problems concerning the following topics.

A. Using the following recipes, develop several problems in which the students convert various units of volume (American). Be sure to include volume measures like bushels, pecks, cups, teaspoons, and other common cooking measures.

Recipes

Make sure all the mussels are alive (they close tightly when touched). Wash them well and pull off the byssus threads or "beard."

Steamed Mussels

2 quarts cleaned mussels
1 onion, chopped
1 cup dry white wine or
1 cup water plus $\frac{1}{4}$ cup
vinegar or 1 cup apple cider
1 bay leaf
parsley
$\frac{1}{4}$ tsp. thyme
$\frac{1}{4}$ tsp. pepper
3 Tbl. butter

Put all ingredients in a large covered pot and bring quickly to a boil. Shake the kettle often so that the mussels cook evenly. Steam over medium heat 5-6 minutes or until shells open. Remove whole mussel meats from shell to eat - good with melted butter and lemon juice.

Creamed Mussels with Dill

2-3 quarts cleaned mussels
1-2 Tbl. margarine or
½-1 Tbl. each butter and oil
2 Tbl. whole wheat pastry flour
1 cup milk
¼ tsp. pepper
½ tsp. salt
1/8 tsp. paprika
dill

Put mussels in large covered pot with small amount of water. Bring quickly to a boil and steam 5-6 minutes, shaking kettle so mussels cook evenly. Remove meats from shells.

Melt margarine or butter and oil in saucepan. Add flour and mix without browning flour. Add milk gradually, stirring rapidly to make a smooth blend. Add pepper, salt, and paprika. Simmer ten minutes. Add 1 Tbl. or more minced plain dill or a few crushed dill seeds. Add mussels. Serve plain or with rice.

B. Basically do the same as A only use metric volumes and masses.

C. Once some degree of proficiency in conversions has been attained among the students, develop some word problems in which these quantity measures are used.

D. Using hypothetical prices (if possible, use actual prices in your area), develop word problems in which shellfishing economics is the topic. For instance, begin with the actual digger who may receive $10.00 per bushel. Then trace the path of these mussels through co-ops, shippers, packers, distributors, and finally to retailers keeping track of all transactions along the way.

E. Using the recipes provided, have students determine the exact cost of preparing a specific dish. If a recipe calls for one cup of flour, for example, the price for that one cup of flour should be used in the solution. Reasonable estimates should be accepted, or may even be given.

As an extension activity, compare the cost of a recipe and its nutritional value with other, more commonly eaten American foods (hamburger recipe, steak, etc.)

Following are a few examples of the type of word problems we have suggested:

1. If you were planning to serve mussels to 100 people how many bushels of mussels would you need to purchase for each person to have 1/3 of a peck apiece?

2. Using metric masses, how much mussel meat would be needed to make stuffed mushrooms for 75 people. What quantities of the other ingredients would be needed?

Stuffed Mushrooms

36 fresh mushrooms, at least 2 inches (5 centimeters) in diameter
1 large clove garlic, chopped
6 tablespoons butter or margarine
1 medium-sized onion, finely chopped
1½ cups (180 grams) fine dry bread crumbs
1 cup (250 grams) cooked, chopped, and drained mussel meats (canned, or fresh steamed by method on page 15)
3 tablespoons sherry
¼ teaspoon finely crumbled oregano
Salt and pepper to taste

Wash mushrooms and pat dry on paper toweling. Remove stems and finely chop half of them (use remainder another time in a stew or an omelet).

Sauté the garlic in butter about 1 minute or until soft; toss in chopped stems and onion; sauté until golden. Remove from heat; add bread crumbs, mussels, sherry, and oregano. Mix well, taste, and add salt and pepper.

Salt mushroom caps inside, then spoon in stuffing. Butter baking pan and put mushrooms on it, stuffing side down. Preheat broiler and broil mushrooms about 5 inches (10 centimeters) below heat for about 2 minutes, or until hot and beginning to soften. With spatula carefully turn each over and broil until light golden brown. Serve piping hot.

Word problems similar to those above which are difficult should be developed.

3. If once mussels are gathered, the musselman sells his mussels to a co-op for $7.50 per bushel, the co-op in turn sells mussels to a packing plant and makes $7.50 profit, the packing plant steams, shucks and cans the mussels, then sells cans containing 250 grams of mussel meat to a retailer for $.75 per can and the retailer then sells canned mussels for $1.50 per can, how much money does each person or business make from this one bushel of mussels?

Conversions

1 bushel of fresh mussels weighs 60 pounds (27 kilograms)

1 bushel of fresh mussels contains 1,000 mussels

1 quart (1 liter) of fresh mussels contains 25 mussels

1 quart (1 liter) of fresh mussels weighs 1½ pounds (750 grams)

3 pounds (1½ kilograms) of fresh mussels when steamed will produce approximately 1 pound (500 grams) of mussel meats

1 quart (1 liter) of fresh mussels when steamed yields 1 cup (¼ liter) of mussel meats

1 cup (¼ liter) of steamed mussel meats weighs about ½ pound (250 grams)

1 cup (¼ liter) of drained mussel meats contains about 25 meats

4. Exactly how much would it cost to make mussel burgers for 8 people?

REFERENCES

The single most thorough resource used in production of this material was:

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